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GROUND PLANES AND PLAIN GROUNDS.

By Clayton F. Bane, W6WB

Much has been written about vertical antennas, noteably about the ground plane operating on 40 and 80 meter bands. Judging solely by the number of questions directed to this writer, much more needs to be written. The probable answer to this is of course the fact that most articles deal with verticals only on an idealized basis, or with installations out on the plains of Oaklahoma. Most city dwellers cannot possibly comply with these conditions.

Suppose you, (like myself) can put up a vertical but only if part of it is close to the house, something like this:

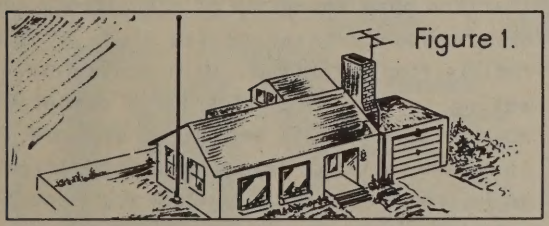
Figure 1.

Let's say now that the overall length of this antenna is one quarter wave and that the base is virtually at ground level. If we can postulate the statement that the portion of the antenna having the greatest current flowing through it contributes the most to the radiated field, it can be clearly seen that in the example given the maximum field will be exactly where it isn't wanted. This particular antenna will do an excellent job of house lighting since the power lines in the building are directly within the maximum radiated field. Ignoring the possibility of dielectric losses, the fact remains that radiation from the antenna will probably be scattered in helter-skelter fashion. Passing over other distressing possibilities, Fig. 1 is not exactly the best way to construct a vertical antenna.

One out is to move the high current loop higher up into the antenna. (Assuming the same positioning as shown in Fig. 1.) This can be done in several ways: Increase the antenna height to ½ wavelength and remove the ground connection from the base. This will mean some 66' at 40 and 132' at 80 and the thought is hardly an enticing one. Getting back down to earth, a much simpler solution might be to make up the bottom half of the antenna by quarter-wave horizontal radials. This might look like the sketches in Fig. 2.

An immediate objection occurs in that the vertical part of the antenna must still be resonant, i. e., a quarter wavelength above the radials. This is not strictly true however. The antenna must be resonant but does not necessarily have to be a quarter wavelength in height above the radials and in fact may be any reasonable length less than this value. In all such cases, it will be capacitive at the base and this capacitive reactance must be cancelled by adding

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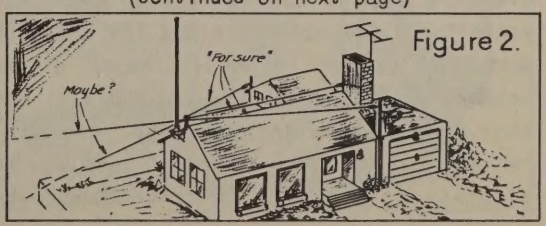


Figure 2.

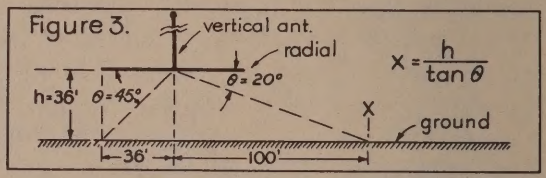
equivalent inductive reactance. (A loading coil). If the antenna can be at least one eigth wave in length, the number of turns required in the base loading coil will be quite nominal and the coil Q may therefore easily be kept to a high value. The magnitude of the antenna losses will be dependent both upon the coil Q and the Q of the antenna. As mentioned in a previous article, antenna Q may be defined as the ratio of antenna reactance to antenna radiation resistance. For antennas shorter than one quarter wavelength this reactance will be capacitive and its value will be dependent upon the antenna length, diameter and general geometry which may influence the capacity-to-ground of the antenna. The longer the antenna, the greater the exposed surface, the greater the capacity and the lower the capacitive reactance. By the same token, the longer the antenna, the higher its radiation resistance. This, antenna Q, $(\frac{X_A}{R})$ will be lower as the antenna approaches a full quarter wave since X decreases and R increases. We tied all this together previously for loaded whips.

The optimum height for a quarter wave antenna appears to be about one quarter wave, (ground to antenna base) where high angle lobes are to be minimized. This means one quarter wave from the reflecting ground which may not be at the actual ground surface.

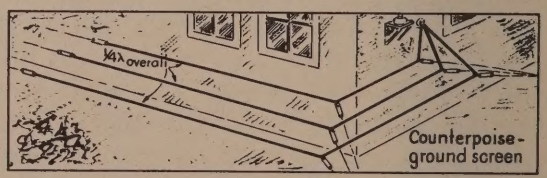
Where do the radials enter into this picture? The radials should be one quarter wavelength and are for the purpose of decreasing ground losses in the immediate vacinity of the antenna since the charging currents flow from the entire length of the antenna to ground, (or to the radials) and thus back to the antenna base. How many radials? An infinite number if possible to simulate an infinite, high conductivity ground plane. Practically, two at least, eight if possible.

Do the radials establish the reflecting ground? Answer this yourself, remembering that DX radiation angles at 40 and 80 approximate 15 to 25 degrees. Assume an antenna base height of 36 feet. A wave front directed downward at a 20 angle from this height would hit ground at a distance of about 100 feet, far beyond the radials. (assuming 36' radials).

Figure 3.



Referring to Fig. 3—it can be seen that only the high radiation angles will be effected by the radials and it this very same high angle effect that causes the radials to have a definite effect upon the base impedance of the antenna. Bear in mind also that the base impedance of the antenna can be changed by changing the angle of the radials from horizontal. It is quite interesting to note that if a large number of quarter wave radials were to be used and if these were tilted downward at the proper angle, the ground plane antenna would eventually change to a modified type of Discone.. a broad band antenna.



Where the so-called radials can only run in one or two directions, the best approach would be to run as many parallel wires as possible and arrange them near to the ground in typical counterpoise fashion.

(Continued on rear page)

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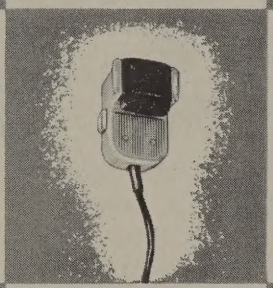

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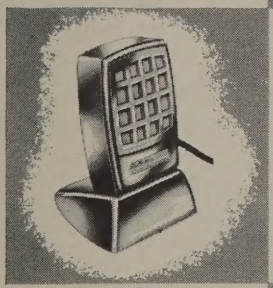

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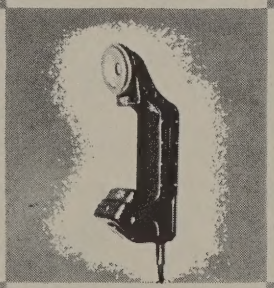

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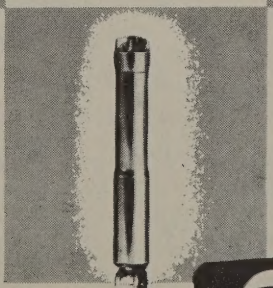

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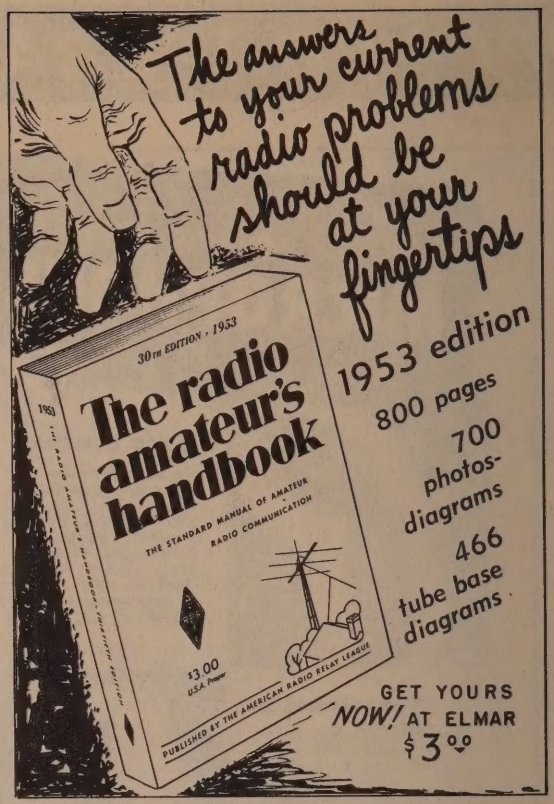
(Continued from inside page)

This arrangement becomes more like a ground screen and the length of the individual wires is not critical assuming somewhere near one quarter wavelength at a minimum.

If the vertical part of the antenna must be less than one quarter wave, use capacity near the top to reduce the Q and to bring the maximum current portion up into the antenna. Try to keep all portions vertical rather than to attempt to make up length by running a long parallel section which may run close to the building. Adjustment of the loaded antenna is relatively simple. Adjust the system to resonance by adjusting the number of turns in the base loading inductor. (Use a grid-dip meter). Normally if the antenna is somewhere near one eighth wave, tuning will be fairly broad and resonance not too sharply defined. After resonating, adjust tap on coil for minimum SWR, not for maximum amplifier loading. If the 52 ohm line is flat it is certain that coupling trouble will be evident. A series or shunt capacitor across the pickup link will be a necessity. (300 to 1000 mmf for 40 or 80). The principal difficulty is that the pickup link does not have sufficient inductance. (assuming the normal 2 to 4 turn pickup link). In stubborn cases, a supplementary series inductor in conjunction with the series or shunt capacitor will do the trick. My four turn pickup link requires about 600 mmf parallel capacity on 80 and about 200 series on 40. Lines are flat in both cases.

If you are going to use power on the loaded vertical don't forget an ample corona ball or ring at the top of the vertical section.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